No 29.

THE
Sidereal Messenger.

Conducted by Wm. W. PAYNE,

Director of Carleton College Observatory.

NOVEMBER, 1884.

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"He telleth the number of the stars; He calleth them all by their names."

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XUM

The Sidereal Messenger.

Conducted by Wm. W. PAYNE, Director of Carleton College Observatory, Northfield, Minn.

"In the present small treatise I set forth some matters of interest to all observers of natural phenomena to look at and consider."—GALILEO, *Sidereus Nuncius*, 1610.

VOL. 3. No. 9. NOVEMBER, 1884. WHOLE No. 29.

PENDING PROBLEMS OF ASTRONOMY.*

[*Continued from page 245.*]

Then there is the very interesting discussion concerning changes upon the *Moon's* surface. Considering the difference between our modern telescopes and those employed fifty or a hundred years ago, I think it still far from certain that the differences between the representations of earlier and later observers necessarily imply any real alterations. But they, no doubt, render it considerably *probable* that such alterations have occurred, and are still in progress; and they justify a persistent, careful, minute and thorough study of the details of the lunar surface with powerful instruments: especially do they inculcate the value of large-scale photographs, which can be preserved for future comparison as unimpeachable witnesses.

I will not leave the *Moon* without a word in respect to the remarkable speculations of Professor GEORGE DARWIN concerning the tidal evolution of our satellite. Without necessarily admitting all the numerical results as to her age and her past and future history, one may certainly say that he has given a most plausible and satisfactory explanation of

*From an address to the American association for the advancement of science at Philadelphia, Sept, 5, 1884, by Prof. C. A. YOUNG, at Princeton, retiring president of the association.—*Science.*

the manner in which the present state of things might have come about through the operation of causes known and recognized, has opened a new field of research, and shown the way to new dominions. The introduction of the doctrine of the conservation of energy, as a means of establishing the conditions of motion and configuration in an astronomical system, is a very important step.

In the planetary system we meet, in the main, the same problems as those that relate to the *Moon*, with a few cases of special interest.

For the most part, the accordance between theory and observation of the motions of the larger planets is as close as could be expected. The labors of LEVERRIER, HILL, NEWCOMB, and others, have so nearly cleared the field, that it seems likely that several decades will be needed to develop discrepancies sufficient to furnish any important corrections to our present tables. LEVERRIER himself, however, indicated one striking and significant exception to the general tractableness of the planets. *Mercury* the nearest to the *Sun*, and the one, therefore, which ought to be the best behaved of all, is rebellious to a certain extent: the perihelion of its orbit moves around the *Sun* more rapidly than can be explained by the action of the other known planets. The evidence to this effect has been continually accumulating ever since LEVERRIER first announced the fact, some thirty years ago; and the recent investigation by Professor NEWCOMB, of the whole series of observed transits, puts the thing beyond question. LEVERRIER'S own belief (in which he died) was, that the effect is due to an unknown planet or planets between *Mercury* and the *Sun*; but, as things now stand, we think that any candid investigator must admit that the probability of the existence of any such body or bodies of considerable dimensions is vanishingly small. We do not forget the numerous instances of round spots seen on the solar disk, nor the eclipse-stars of WATSON, SWIFT, TROUVELOT, and others; but the demonstrated possibility of error or mistake in all these cases, and the tremendous array of negative evidence from the most trust-

worthy observers, with the best equipment and opportunity, makes it little short of certain that there is no *Vulcan* in the planetary system.

A ring of meteoric matter between the planet and the *Sun* might account for the motion of the perihelion; but, as NEWCOMB has suggested, such a ring would also disturb the *nodes* of *Mercury's* orbit.

It has been surmised that the cause may be something in the distribution of matter within the solar globe, or some variation in gravitation from the exact law of the inverse square, or some supplementary electric or magnetic action of the *Sun*, or some special effect of the solar radiation, sensible on account of the planet's proximity, or something peculiar to the region in which the planet moves; but as yet no satisfactory explanation has been established.

Speaking of unknown planets, we are rather reluctantly obliged to admit that it is a part of our scientific duty as astronomers to continue to search for the remaining asteroids; at least, I suppose so, although the family has already become embarrassingly large. Still I think we are as likely to learn as much about the constitution, genesis, and history of the solar system from these little flying rocks as from their larger relatives; and the theory of perturbations will be forced to rapid growth in dealing with the effects of *Jupiter* and *Saturn* upon their motions.

Nor is it unlikely that some day the searcher for these insignificant little vagabonds may be rewarded by the discovery of some great world, as yet unknown, slow moving in the outer desolation beyond the remotest of the present planetary family. Some configurations in certain cometary orbits,and some almost evanescent peculiarities in *Neptune's* motions, have been thought to point to the existence of such a world; and there is no evidence, nor even a presumption against it.

Mercury, as yet, defies all our attempts to ascertain the length of its day, and the character and condition of its surface. Apparently the instruments and methods now at command are insufficient to cope with the difficulties of the

problem; and it is not easy to say how it can be successfully attacked.

With *Venus*, the *Earth's* twin-sister, the state of things is a little better: we do already know, with some degree of approximation, her period of rotation; and the observations of the last few months bid fair, if followed up, to determine the position of her poles, and possibly to give us some knowledge of her mountains, continents, and seas.

It would be rash to say of *Mars* that we have reached the limit of possible knowledge as regards a planet's surface; but the main facts are now determined, and we have a rather surprising amount of supposed knowledge regarding his geography. By "supposed," I mean merely to insinuate a modest doubt whether some of the map-makers have not gone into a little more elaborate detail than the circumstances warrant. At any rate, while the "areographies" agree very well with each other in respect to the planet's more important features, they differ widely and irreconcilably in minor points.

As regards the physical features of the asteroids, we at present know practically nothing: the field is absolutely open. Whether it is worth anything, may be a question; and yet, if one *could* reach it, I am persuaded that a knowledge of the substance, form, density, rotation, temperature, and other physical characteristics, of one of these little orphans, would throw vivid light on the nature and behavior of interplanetary space, and would be of great use in establishing the physical theory of the solar system.

The planet *Jupiter*, lordliest of them all, still, as from the first, presents problems of the highest importance and interest. A sort of connecting-link between *Suns* and planets, it seems as if, perhaps, we might find, in the beautiful and varied phenomena he exhibits, a kind of halfway house between familiar terrestrial facts and solar mysteries. It seems quite certain that no analogies drawn from the *Earth* and the *Earth's* atmosphere alone, will explain the strange things seen upon his disk, some of which, especially the anomalous differences observed between the rotation pe-

riods derived from the observation of markings in different latitudes, are very similar to what we find upon the *Sun*. "The great red spot" which has just disappeared, after challenging for several years our best endeavors to understand and explain it, still, I think, remains as much a mystery as ever,—a mystery probably hiding within itself the master-key to the constitution of the great orb of whose inmost nature it was an outward and most characteristic expression. The same characteristics are also probably manifested in other less conspicuous but equally curious and interesting markings on the varied and ever-changing countenance of this planet; so that, like the *Moon*, it will well repay the most minute and assiduous study.

Its satellite system also deserves careful observation, especially in respect to the eclipses which occur; since we find in them a measure of the time required for light to cross the orbit of the *Earth*, and so of the solar parallax, and also because, as has been already mentioned, they furnish a test of the constancy of the *Earth's* rotation. The photometric method of observing these eclipses, first instituted by Professor PICKERING at Cambridge in 1878, and since re-invented by CORNU in Paris, has already much increased the precision of the results.

With reference to the mathematical theory of the motion of these satellites, the same remarks apply as to the planetary theory. As yet, nothing appears in the problem to be beyond the power and scope of existing methods, when carried out with the necessary care and prolixity; but a new and more compendious method is most desirable.

The problems of *Saturn* are much the same as those of *Jupiter*, excepting that the surface and atmospheric phenomena are less striking, and more difficult of observation. But we have, in addition, the wonderful rings, unique in the heavens, the loveliest of all telescopic objects, the type and pattern, I suppose, of world-making, in actual progress before our eyes. There seems to be continually accumulating evidence from the observations of STRUVE, DAWS, HENRY, and others, that these whirling clouds are changing in their

dimensions and in the density of their different parts; and it is certainly the duty of everyone who has a good telescope, a sharp eye, and a chastened imagination, to watch them carefully, and set down exactly what he sees. It may well be that even a few decades will develop most important and instructive phenomena in this gauzy girdle of old *Chronos*. Great care, however, is needed in order not to mistake fancies and illusions for solid facts. Not a few anomalous appearances have been described and commented on, which failed to be recognized by more cautious observers with less vivid imaginations, more trustworthy eyes, and better telescopes.

The outer planets, *Uranus* and *Neptune*, until recently, have defied all attempts to study their surface and physical characteristics. Their own motions and those of their satellites, have been well worked out; but it remains to discuss their rotation, topography, and atmospheric peculiarities. So remote are they, and so faintly illuminated, that the task seems almost hopeless; and yet, within the last year or two, some of our great telescopes have revealed faint and evanescent markings upon *Uranus*, which may in time lead to some further knowledge of that far-off relative. It may, perhaps, be that some great telescope of the future will give us some such views of *Neptune* as we now get of *Jupiter*.

There is a special reason for attempts to determine the rotation periods of the planets, in the fact that there is very possibly some connection between these periods, on the one hand, and, on the other, the planets' distances from the *Sun*, their diameters and masses. More than thirty years ago, Professor KIRKWOOD supposed that he had discovered the relation in the analogy which bears his name. The materials for testing and establishing it were then, however, insufficient, and still remain so, leaving far too many of the data uncertain and arbitrary. Could such a relation be discovered, it could hardly fail to have a most important significance with respect to theories of the origin and development of the planetary system.

The great problem of the absolute dimensions of our

system is, of course, commanded by the special problem of the solar parallax; and this remains a problem still. Constant errors of one kind or another, the origin of which is still obscure, seem to affect the different methods of solution. Thus, while experiments upon the velocity of light and heliometric measurements of the displacements of *Mars* among the stars agree remarkably in assigning a smaller parallax (and greater distance of the *Sun*) than seems to be indicated by the observations of the late transits of *Venus*, and by methods founded in the lunar motions, on the other hand, the meridian observations of *Mars* all point to a larger parallax and smaller distance. While still disposed to put more confidence in the methods first named, I, for one, must admit that the margin of probable error seems to me to have been rather increased than diminished by the latest published results deduced from the transits. I do not feel so confident of the correctness of the value 8″.80 for the solar parallax as I did three years ago. In its very nature, this problem is one, however, that astronomers can never have done with. So fundamental is it, that the time will never come when they can properly give up the attempt to increase the precision of their determination, and to test the received value by every new method that may be found.

The problems presented by the *Sun* alone might themselves well occupy more than the time at our disposal this evening. Its mass, dimensions, and motions, as a whole, are, indeed, pretty well determined and understood; but when we come to questions relating to its constitution, the cause and nature of the appearances presented upon its surface, the periodicity of its spots, its temperature, and the maintenance of its heat, the extent of its atmosphere, and the nature of the corona, we find the most radical differences of opinion.

The difficulties of all solar problems are, of course, greatly enhanced by the enormous difference between solar conditions and the conditions attainable in our laboratories. We often reach, indeed, similarity sufficient to establish a bond of connection, and to afford a basis for speculation; but the

dissimilarity remains so great as to render quantitative calculations unsafe, and make positive conclusions more or less insecure. We can pretty confidently infer the presence of iron and hydrogen and other elements in the *Sun* by appearances which we can reproduce upon the *Earth*; but we cannot safely apply empirical formulæ (like that of DULONG and PETIT, for instance), deduced from terrestrial experiments, to determine solar temperatures; such a proceeding is an unsound and unwarrantable extrapolation, likely to lead to widely erroneous conclusions.

For my own part, I feel satisfied as to the substantial correctness of the generally received theory of the *Sun's* constitution, which regards this body as a great ball of intensely heated vapors and gases, clothed outwardly with a coat of dazzling clouds formed by the condensation of the less volatile substances into drops and crystals like rain and snow. Yet it must be acknowledged that this hypothesis is called in question by high authorities, who maintain with KIRCHOFF and ZOLLNER, that the visible photosphere is no mere layer of clouds, but either a solid crust, or a liquid ocean of molten metals; and there may be some who continue to hold the view of the elder *Herschel* (still quoted as authoritative in numerous school-books), that the central core of the *Sun* is a solid and even habitable globe, having the outer surface of its atmosphere covered with a sheet of flame maintained by some action of the matter diffused in the space through which the system is rushing. We must admit that the question of the *Sun's* constitution is not yet beyond debate.

And not only the constitution of the *Sun* itself, but the nature and the condition of the matter composing it, is open to question. Have we to do with iron and sodium and hydrogen as we know them on the *Earth*, or are the solar substances in some different and more elemental state?

However, confident many of us may be as to the general theory of the constitution of the *Sun*, very few, I imagine, would maintain that the full explanation of the Sun-spots and their behavior has yet been reached. We meet contin-

ually with phenomena, which, if not really contradictory to prevalent ideas, at least do not find in them an easy explanation.

So far as mere visual appearances are concerned, I think it must be conceded, that the most natural conception is that of a dark chip or scale thrown up from beneath, like scum in a caldron, and floating, partly submerged, in the blazing flames of the photosphere which overhang its edges, and bridge across it, and cover it with filmy veils, until at last it settles down again and disappears. It hardly *looks* like a mere hollow filled with cooler vapor, nor is its appearance that of a cyclone seen from above. But then, on the other hand, its spectrum under high dispersion is very peculiar; not at all that of a solid, heated slag, but it is made up of countless fine dark lines, packed almost in contact, showing, however, here and there a bright line, or at least an interspace where the rank is broken by an interval wider than that which elsewhere separates the elementary lines,—a spectrum, which, so far as I know, has not yet found an analogue in any laboratory experiment. It seems, however, to belong to the type of absorption spectra, and to indicate, as the accepted theory requires, that the spot is dark in consequence of *loss* of light, and not from any original defect of luminosity. Here, certainly, are problems that require solution.

The problen of the *Sun's* peculiar rotation and equatorial acceleration is a most important one and still unsolved. Probably its solution depends in some way upon a correct understanding of the exchanges of the matter going on between the interior and the surface of the fluid, cooling globe. It is a significant fact (already alluded to), that a similar relation appears to hold upon the disk of *Jupiter*; the bright spots near the equator of the planet completing their rotation about five minutes more quickly than the great red spot which was forty degrees from the equator. It is hardly necessary to say that an astronomer, watching our terrestrial clouds from some external station (on the *Moon*, for instance), would observe just the reverse. Equa-

torial clouds would complete their revolution more slowly than those in our own latitude. *Our* storms travel toward the east, while the volcanic dust from Krakatoa moved swiftly west. We may at least conjecture that the difference between different planets somehow turns upon the question, whether the body whose atmospheric currents we observe is receiving more heat from without than it is throwing off itself. Whatever may be the true explanation of this peculiarity in the motion of sun-spots, it will, when reached, probably carry with it the solution of many other mysteries, and will arbitrate conclusively between rival hypotheses.

The periodicity of the sun-spots suggests a number of important and interesting problems; relating, on the one hand, to its mysterious cause, and, on the other, to the possible effects of this periodicity upon the earth and its inhabitants. I am no 'sun-spottist' myself, and am more than sceptical whether the terrestrial influence of sun-spots amounts to anything worth speaking of, except in the direction of magnetism. But all must concede that this is by no means yet demonstrated (it is not easy to prove a negative); and there certainly are facts and presumptions enough tending the other way to warrant more extended investigation of the subject. The investigation is embarrassed by the circumstance, pointed out by Dr. Gould, that the effects of sun-spot periodicity, if they exist at all (as he maintains they do), are likely to be quite different in different portions of the earth. The influence of changes in the amount of the solar radiation will, he says, be first and chiefly felt in alterations and deflections of the prevailing winds, thus varying the *distribution* of heat and rain upon the surface of the earth without necessarily much changing its absolute amount. In some regions it may, therefore, be warmer and drier during a sun-spot maximum, while in adjoining countries it is the reverse.

[*To be continued.*]

AMOUNT OF ATMOSPHERIC ABSORPTION.*

The earth is surrounded by an absorbing atmoshpere, and we never see the *Sun* or stars except through it. To determine the absolute brightness of these bodies, we must first know the degree and kind of this absorption, and add the amount of it to the observed quantities of light at the surface of the *Earth*.

The earliest observations of the last century gave the light absorption as 19 per cent. of the whole (at sea level). The elaborate ones by SEIDEL, of Munich, 21 per cent.; PRITCHARD, of Oxford, 21 per cent., the most recent by MUELLER, of Potsdam, 17, and those of POUILLET on the *Sun's* heat gave 18 to 24 per cent. Almost all of a great number of observations of 'light' or 'heat' that might be cited, give about 20 per cent. Late observations show, on the whole, that 'light' rays are more absorbable than those of 'heat,' and that in particular, blue light is much more so; the difference between the two mean co-efficients being small. The careful series of observations by ERICSSON on the *Sun's* heat gives about 21 per cent. After citing all these authorities and noticing the close agreement of their results, Professor LANGLEY says, "I have arrived at a result so wholly different, that in the face of such authority, I almost hesitate to announce it; for I have been forced to the conclusion, that all these determinations are in error; and not in some small degree, but by a quantity at least equal to the total amount in question."

He does not question the general accuracy of the above-named skillful investigators and others, but he does claim that the common method of reducing their observations is erroneous, and singularly, too, this error is always in one direction.

Professor LANGLEY reaches his conclusions from both theoretical and experimental investigation. It is well

*Abstract of a communication made to the National Academy of Sciences, April, 1884, by Professor S. P. Langley, Allegheny Observatory.

known to the readers of the MESSENGER, that he has been engaged for years in observations of this kind at home and abroad, at sea level and at great altitudes, and that he has established the fact that the laws under which solar and stellar light and heat are absorbed by the atmosphere are so complex that their complete comprehension is still beyond our power, and that we may improve our ways of studying them, because certain facts pertaining to atmospheric absorption are now better understood, than they were formerly.

In methods of study heretofore the atmosphere was thought of as a homogeneous absorbing medium, divided in imagination, into successive strata of identical thickness and chemical constitution. Then, suppose A to be a source of radiant heat or light whose intensity is reduced in passing through the first stratum to a fraction of the original quantity represented by p, so that what was A becomse Ap. Then, since the second stratum is identical with the first in constitution and amount, it is assumed that a like effect will be produced on the quantity Ap which will result in Ap^2; after the third stratum the result will be Ap^3 etc., until e strata would give a result of Ap^e. But these expressions indicate that the amount transmitted at any point will be proportional to the ordinate of a logarithmic curve, a law, if true, easily understood and simple in application. Then by observation two equations may be obtained in the form of $Ap^2 = m$, $Ap^3 = n$, from which both A and p become known. Now if we designate the number of strata e, then $Ap^e = t$; the exponential formula of POUILLET and later investigators. Its fundamental (and erroneous) assumption is that the co-efficient of transmission (p) is a constant.

It is doubtless true that radiation is not simple but complex. Heat, like light, is of different kinds. Could we see it, it would appear of totally different colors, and we ought no more attribute to it a single rate of absorption in any medium than to assume that a blue and a red ray would pass through a red glass with equal facility. The bearing of this fact on the question in hand is plain. Solar energy,

whether regarded in whole as 'heat' or 'chemical action,' or in part as 'light' is the sum of an infinite number of radiations conceivably influenced in an infinite number of ways by varying atmospheric conditions. The larger particles reflect the light and heat treating all wave-lengths alike, or diminish the direct radiation by nearly general absorption; minuter ones begin to act selectively, or on the whole, more at one end of the spectrum than the other; smaller particles of dust or faintest mist, and smaller ones still form probably a continuous sequence of more and more selective action, down almost to the actual molecule whose vibration is felt in the finely selective absorption of some single ray. The effect of the action of the grosser dust particles is to produce absorption of all rays, and the spectrum is equally less bright and less hot. The effect of the molecular absorption is selective action, in the form of dark telluric lines, taking out some kinds of light and heat, and not others, so that after absorption what remains is not only less in amount but altered in kind.

From this it must appear that the co-efficient of transmission is truly constant only in the case of the absolutely homogeneous ray; and hence the great difficulty of determining the or iginal lightfrom a star, or heat of the *Sun*; by any known methods. If a certain narrow space of the spectrum is measured and its co-efficient of transmission determined in the function of wave-lengths, we can not take the integral of that function because the unit is really discontinuous. Professor LANGLEY then treats this most interesting problem by ordinary algebraic processes and deduces four important results, as follows:

When the separate co-efficients of transmission are positive and less than unity (as is the case in Nature) the general co-efficient of transmission in the customary experimental formula is:

1. Never a constant (as determined from the customary formula).
2. Always too large.
3. Always larger and larger as we approach the horizon.

4. The original light or heat of the heavenly body determined by common methods is always too small, a conclusion which is reached in two different ways.

[*To be continued.*]

NAVAL OBSERVATORY AT WASHINGTON,

PROFESSOR RALPH COPELAND.

The distinguished astronomer, Professor RALPH COPELAND. of Dun Echt observatory, Scotland, recently visited the principal observatories of the United States, and his remarks concerning the Naval Observatory at Washington appear in the last issue of the *Astronomical Register* as follows:

The great 26-inch equatorial differs only in size from the rest of the telescopes made by Messrs. ALVAN CLARK& Sons. It has the same somewhat light mounting and axes, the same plain well-proportioned tube of riveted steel plates and the same absence of nearly all the outer fittings and adjuncts that are considered desirable about large instruments in Europe. It is indirectly driven by water which continually winds up the clock-weight. The clamping in declination is done in the usual way with a long rod, but both the slow motions, the clamping in right ascension and a special quick motion in hour angle are effected by cords. The white setting-circles are lit up when required by gas-light reflected from the wall by concave glass mirrors. The setting is done by the attendant who manages the dome and also throws light from a bull's-eye lantern into the end of the micrometer when bright-wire illumination is desired. The parallel wire micrometer has but one measuring screw, as with the considerable focal lengths of our large instruments it is quite possible to construct micrometer screws that are practically perfect, and thus do away with the necessity of changing the zero-point to eliminate periodic error. The sidereal clock is let into the wall of the dome so as to be out of the way. In short, everything is done to give free scope to the observer and to simplify the instrument, trusting to skill on the astronomer's part and considerable zeal on that of the attendant to meet the ever-varying demands of the work in progress.

On the evening of August 18, 1883, Professor Hall had

the great kindness to show the writer a number of objects through telescope. α Lyræ with powers of 400 and 600 exhibited a sharp central disk with fine brilliant uniformly distributed rays on a moderate ground of outstanding palish blue; of course, the well-known companions were egregiously conspicuous. The action of the lens did not strike me as being different from that of the best telescopes with which I was acquainted. ε Lyræ was looked at chiefly as being a familiar object and one that the writer had just seen through a 12-inch Alvan Clark glass. The moonlight and some hazy cloud doubtless prevented the gain in light from being specially evident. Σ 2422 with a central distance of about 0″·8 gave an opportunity of making a demand on a power of 900. A sketch repeatedly compared with the object shows the disks to have been about 0″·4 in diameter and consequently separated by that interval. $O\Sigma$ 387 with a distance of about half a second of arc was so distinctly separated as to give the assurance that under very favorable circumstances the glass might be trusted to work down to the closest theoretical limits of rather less than two-tenths of a second of arc provided the component stars were fairly equal and not too brilliant. Mr. Burnham's companion to β Aquilæ was so obvious that it could not be considered a test object. The instrument was very steady, but yielded in an elastic manner to the extent of one minute or so of arc when lightly pressed at right angles to the meridian, thus indicating a want of transverse stiffness in the mounting. The attendant did the setting quickly by the aid of the coarsely-divided painted circles, Professor HALL dictating the hour angles and the polar distances. The equatorial stands on the main floor of the observatory in a comparatively lightly-constructed building with the usual hemispherical dome moved on a plan little differing from that of the Dublin dome. The opening is 6½ feet wide and is covered by a sheet of oiled canvas running in guides and let down in a nautical fashion when the telescope is in use. The special computing room for the equtoreal work adjoins the dome. The cost of the instrument was £9,000, of which about £1,200 were paid to Messrs. CHANCE BROTHERS & Co., of Birmingham, for the glass disks

Mounted in a dome surmounting the whole observatory is a 9·6-inch Munich equatorial of the usual construction. This, the fine Mural circle by TROUGHTON & SIMMS, as well as the 7-foot transit by ERTEL, do not call for special remark. The great transit-circle by PISTOR & MARTINS has

a telescope of 12 feet focal length and 8½ inches aperture with interchangeable ends. The collimators are of the usual small German type, having only 2½ inches aperture, so that it may well be doubted whether the results they give fairly represent the collimation of the main telescope. The two movable circles have an effective diameter of 43·4 inches and are divided to every 2′, each being read by four microscopes. The instrument is arched over with ladders, much on the Greenwich plan, so as to afford every facility for reflex and nadir observations. Professor NEWCOMB'S researches show that the graduations of the circles are remarkably free from systematic errors and that greater final accuracy is to be expected from occasionally changing their positions so as to use fresh divisions, than by the most elaborate determination and application of division corrections. The walls of the building are of thin sheet iron shaded by louvre-work on the outside. The inside temperature is found to differ very little from that of the external air. In a small detached building is a new reversible transit-instrument made by Messrs. STACKPOOLE Bros., of New York, from designs by Professor HARKNESS. In it the bearings are segments of cylinders—a detail of construction worthy of more general imitation.

All the photographs of the recent transit of *Venus* taken by the American parties are now being measured at the the Naval Observatory under the supervision of Professor HARKNESS, who has devised most ingenious apparatus for the purpose. Polar co-ordinates are measured and referred to the photographed image of a plumb-line, whose support was regularly varied to eliminate *kink*. Between 1,300 and 1,400 pictures are available. Tney were taken with long-focus lenses, through which the light was thrown by unsilvered mirrors, both being made by the CLARKS. The writer saw some spirit levels of a novel construction in which the tube was enclosed in close proximity to the glass lid of a box; the divisions being on the underside of the covering and not on the lube, Professor HARKNESS being of the opinion that the figure and elasticity of the tube are injured by the ordinary divisions.

A new 7-inch heliometer is to be made for the Cape observatory, for work in charge of Dr. GILL. It will cost £2700, and is being constructed by Messrs. REPSOLD, of Hamburg.

GREENWICH, THE WORLD'S MERIDIAN.

According to announcement, the International Conference to fix a prime meridian for the world, assembled at Washington, Oct. 1. Forty delegates, representing twenty-five nations, were present. This country was represented by Admiral C. R. P. Rogers, L. M. Rutherford, W. F. Allen, Commander W. T. Sampson and Professor C. Abbey. By vote of the conference, Professor Newcomb, Dr. Hilgard Professor Hall, Dr. Valentiner (Karlsruhe observatory) and Sir William Thompson were invited to the meetings of the conference, and to participate in the discussion of questions under consideration. After considerable discussion as to the details of work, Mr. Rutherford, of the United States, offered the following resolution:

"That the conference proposes to the governments here represented the adoption of the meridian passing through the center of the transit instrument at the Observatory of Greenwich, as the initial meridian for longitude."

"Mr. Fleming, of Canada, moved as an amendment, that the conference adopt the 180th degree of longitude, east or west from Greenwich as the prime meridian, but the other delegates from Great Britain opposed this amendment and it was lost.

"Mr. Valera, the Spanish minister, stated that he had been instructed by his government, in voting for the meridian of Greenwich, to say that he hoped the Metric System of weights and measures would be adopted by England, the United States and the other nations here represented, as recommended by the conference at Rome.

"Gen. Strachey, of Great Britain, said that he was authorized to state that his country had asked to be allowed to join the Metric convention, and that the Metric System was already recognized by the laws of Great Britain, and was in use for scientific purposes. He could not, however, say that it would be adopted under any circumstances as the popular system of weights and measures throughout the kingdom.

"Mr. W. F. Allen, of the United States, made an argument in behalf of the meridian of Greenwich, and presented the resolutions adopted by the railroad convention in Philadelphia, protesting against a change of meridian.

"Mr. Lefaivre, of France, said that the meridian of Greenwich was not the scientific meridian; that it implied no progress in any of the sciences, but was merely a commercial standard. Since, therefore, nothing would be gained to science by adopting Greenwich, France could not make a sacrifice of her own meridian, and incur the vast expense consequent upon the adoption of a new one, because she would thereby gain no advantage whatever."

"Mr. Janssen, of France, was in favor of a neutral meridian, and was not interested in the discussion, if that principle were rejected. He maintained that the 'need of a common prime meridian was limited to Geography and Hydrography alone, and were wholly independent of Astronomy and Geodesy.

"Professor Adams, of England, spoke of the dependence of all meridians on astronomical observations, and the difficulty of getting any of high accuracy on account of the irregular figure of the *Earth*; that there could not be any important distinction between geographical and astronomical longitudes as such, although so claimed by some delegates of the conference.

"Sir William Thompson, who is delivering lectures in Baltimore, was present then as a guest, and by invitation of the conference spoke at some length in favor of the adoption of Greenwich. He held that it was purely a matter of convenience, and that Greenwich answered the convenience of the world better than any other standard meridian.

"There was an effort made to discuss the subject of the Metric System of weights and measures, but the president stated that, as that subject was not referred to in the acts of Congress relating to the conference, or in the official circulars issued by the president of the United States, it was not a proper subject for present discussion.

"Sir Frederick Evans, of Great Britain, then presented a comparative statement, showing that the tonnage of shipping controlled by the Greenwich standard of longitude was, in round numbers, 14,000,000 tons, while that controlled by the Paris standard was only 1,735,000 tons. He also submitted a statement of the number of charts, etc., purchased by nations outside of Great Britain for scientific and commercial purposes, in order to show how largely that meridian is now being used.

"Mr. Rutherford's resolution in favor of Greenwich, as the prime meridian was then adopted, twenty-one nations voting in favor of it, one (San Domingo) against it, and France and Brazil abstaining from voting.

"Mr. Rutherford then moved the adoption of the following resolution: 'From this meridian (Greenwich) longitude will be counted in two directions up to 180 degrees, east longitude being plus and west longitude minus.' The Russian minister spoke in favor of this resolution."

After extended discussion, Mr. Rutherford's second resolution was adopted by a small majority.

The very general agreement of this conference, in selecting the meridian of Greenwich, as the zero for longitude for the world, is a step in advance for science. On the other hand, it is a matter of wonder and regret that the apparently strong reasons in favor of reckoning longitude one way to 360° only, should not have carried with equal unanimity.

It can scarcely be supposed that any scientist of national reputation, judging of that which is best for the common cause, would prefer two systems of equal longitudes on the *Earth's* surface, having the importance difference only of an algebraic sign. If dipolmatic relations were to be regarded as the chief factor in the problem, it is then easy to see why two or a dozen different systems should be maintained.—*Editor.*

NOTES RELATING TO MERIDIAN CIRCLES.

BY JOHN TATLOCK, JR.

During the past year, while engaged in meridian work, I have made, from time to time, notes on the values of the constants pertaining to different instrumeuts, for comparison with the values which were found to belong to the instrument with which I was working. More especially I have searched for the value of the probable errors which different observers have ascribed to their results. In what follows I have given a part of these notes which I have collected, as they may be of interest to some of the readers of the MESSENGER. I have made no attempt to make a full and complete collection of existing data on the various subjects, but have simply put down those which have casually come under my notice.

In most cases I have given the authority, where none is given, it is to be understood that the information was derived from private sources.

Prof. HOLDEN wishes me to state that everything which pertains to the Madison meridian circle is to be regarded as merely approximate and preliminary.

VALUE OF THE FLEXURE CONSTANT OF VARIOUS INSTRUMENTS.

Dr. GOULD, at Cordoba, with the Repsold meridian circle, finds 0.″7.

(Annals, vol. II).

Prof. ROGERS, at Cambridge, Mass., with the Troughton & Simms meridian circle, found, by using collimators, in May 1876, a constant of 2.″03. Another series, in the same month by another observer, gave 1.″83. In December 1876, he found 1.″77, and in January 1877, after the reversal of the instrument, he found a constant of 0.″94.

The value that has been used at Cambridge is 2.″37, which is derived from the observation of the fundamental stars.

(Annals H. C. O., vol. X).

At Greenwich, Eng., Mr. AIRY found 0.″41 as the flexure constant of the large transit circle, (Chauvenet's Astronomy, vol. II). In May 1881, the constant was determined to be 0.″15. (Introd. to Gr. obs. 1881). The value used in 1883 was −0.″49.

(Introd. to Gr. obs. 1883).

Prof. BOSS, at Albany. with the P. & M. circle, used for the zone observations, a constant of 0.″47.

(V. J. S., 1880).

BESSEL, with the Reichenbach circle, in 1820-21, found 0.″56.

(Boss' Report on the declination of the fixed stars).

DUNER, at Lund, uses for the zone, 0.″57. P. &. M circle.

(Perrotin, *Visite de l' observatoires d' Europe*).

At Paris, Lowy's apparatus gave a constant of 1″.03 and the collimators 1.″15.

(Copernicus, vol. I, p. 90).

For the Dunsink meridian circle, P. & M.—the constant is—0.″53 for circle east, and —0″.05 for circle west.

(Ast. Researches, made at Dunsink, vol. IV.)

On the Leyden meridian circle—P. &. M.—both circles are divided. One gives a flexure constant of 0.″23 and the otber 0.″09.

(Annalen, B and II).

CARRINGTON, with the Troughton & Simms circle, found 0.″60.

(Redhill Catalogue).

For the Pulcova meridian circle the flexure of the telescope + the flexure of one circle was found to be + 1.″68. With the other circle this became + 2.″41.

(*Struve's Description de 'l observatoire central*).

Dr. SCHUR, at Strassburg, with the Repsold circle finds 0.″13.

RESPIGHI, at Rome, in his latitude determination, used 0.″94.

(Declinazioni medie pel. 1875.0 di 285 stelle.)

For the Washington transit circle—P. & M.—the constant is about — 0.″9.

(Washington Obs. 1872).

At Madison, in 1883-84, with the Repsold meridian circle, one observer found the constant to be — 0.″13, and another — 0.″17.

PROBABLE ERROR OF A SINGLE POINTING OF ONE MICROSCOPE OF A MERIDIAN CIRCLE.

PETERS, with the Pulcova Vertical circle, found ± 0.″090 at night and ± 0.″098 by day.

(Struve, *Description de l' observatoire central*).

Dr. GOULD, at Cordoba, with the Repsold circle, thinks that it cannot be less than ± 0.″2.

Prof. NEWCOMB, at Washington, with the P. & M. circle, found ± 0.″10.

(Wash. Obs. 1865. Description of transit circle).

STRUVE, at Berlin, in 1820, with a Pistor circle, found ± 0.″16.

(Description de l' observatoire central).

Dr. SCHUR, at Strassburg in 1883, with the Repsold circle, finds ± 0.″3.

Prof. Boss, at Albany, thinks that, with his circle he cannot reduce the p. e. of a single pointing below ± 0.″2.

(V. J. S., 1880).

At Madison, with the Repsold circle, Prof. HOLDEN found in 1882, for this quantity ± 0.″15, and Mr. COMSTOCK found ± 0.18. In September 1883, from a special series of observations for the purpose of determining this quantity, I found ± 0.″11. In October 1883, I found, from a number of observations to determine error of runs, ± 0.″16 In June 1884, from an extended series of readings, for the purpose of determining division error, I found ± 0.″14.

PROBABLE ERROR OF A SINGLE OBSERVATION IN RIGHT ASCENSION AND DECLINATION.

Dr. ROBINSON, at Armagh, finds ± 0ˢ.080 sec. δ and ±0.″816.

(Places of 1000 stars).

Prof. ROGERS, at Cambridge, finds ± 0.ˢ024 sec. δ and ± 0.″66 from two microscopes, and ± 0.′39 when four are read.

(Annals, H. C. O. vol. x).

M. SCHÆBERLE, at Ann Arbor, found ± 0.ˢ040 sec δ and ± 0.″55.

(Publications of the Washburn Observatory, vol. i).

Prof. SAFFORD, at Williamstown, in 1882, in his circumpolar work, found ± 0.ˢ0264 sec. δ.

(SIDEREAL MESSENGER, May, 1883.

Mr. DUNKIN, from a discussion of the Greenwich observations, found ± 0.ˢ017 by the chronographic method. For a transit over a single wire he found ± 0.ˢ078 eye-and-ear, and ± 0.ˢ051 chronographi·.

(Monthly Notices, R. A. S. 1863).

Dr. DREYER, at Dunsink, found in dec. ± 0.″63, for stars north of—10°, and ±0.″73 for stars between—10° and—26°. He also found the p. e. of a clock correction from a *single*

star to be $\pm$ 0.^{s}052. and the p. e. of an equator-point from a single star to be $\pm$ 0.″55.

(Ast. Researches, made at Dunsink, part IV).

SCHELLERUP, at Copenhagen, P. & M. circle, gives the p. e. of a single polar point as $\pm$ 0.″53. The p. e. of a clock correction from a *single* star is $\pm$ 0.^{s}056. and the p. e. of a single complete observation in R. A. in $\pm$ 0.^{s}036.

(Catalogue of 10,000 stars).

Prof. COFFIN, with the Mural circle. at Washington, found $\pm$ 0.″55.

(Washington Obs. 1846).

With the Pulcova Vertical circle, the p. e. of one obs. in δ is $\pm$ 0.″17. This is from the observations for the determination of the latitude.

(*Description de l' observatoire central*).

Dr. COPELAND, at Dunsink in 1875-76, found $\pm$ 0^s.049 and $\pm$ 0.″44.

(Dun Echt Obs. Pub. vol. II).

At Washington in 1877, from the observation of the *Mars* comparison stars, the p. e. of one observation is found to be $\pm$ 0.″30 from the work of all the observers, and $\pm$0.″23 from the work of three.

(Washington Obs. 1877. Appendix III).

At Leyden. for these same stars the p. e. of one observation was $\pm$ 0.″26.

(Same reference as above).

At Melbourne, from the observations of the same stars, this quantity is found to be $\pm$ 0.″35.

(Same reference as above).

Dr. HILFIKER, at Neuenberg in 1883, found for one observation in δ $\pm$ 0.″67.

(Ast. Nach. No. 2541).

At Madison, from a preliminary discussion of the observations of the Southern fundamental stars, there have been found the following:

p. e. of a transit over one wire, $\pm$ 0.^{s}058.

p. e. of a clock correction from a single star, $\pm$ 0.″028.

p. e. of an equator point from a single star, $\pm$ 0.″4.

EDITORIAL NOTES.

A very suggestive and thoughtful paper by M. THOLLON, has appeared in the *Bulletin Astronomique*, (French), on the *Constitution and Origin of the group* B *of the Solar Spectrum.* It will be read with profit, in connection with a late paper elsewhere, noticed from the pen of Professor LANGLEY. The study of the metallic and the telluric lines in this region of the solar spectrum indicates surprising results, if the writer is correct in his theory. The closing paragraphs of the paper will indicate something of its drift, especially regarding Captain ABNEY'S views, which were set forth in *Nature* (Oct. 12, 1882, p. 585). The position then taken, was that the groups A and B can not be regarded as telluric, but as proceeding from a medium lying some where between the *Sun* and *Earth.* PIAZZI SMYTH adopted the same views, and the later work of Mr. SIEMENS seemed to be confirmatory. Most of our readers perhaps may already know that a telluric line in the spectrum is a "very narrow, black and cold region, where the absorption has already done its full work, or which is at any rate so black and so cold, that it can grow very little blacker or colder." On this point Mr. THOLLON says:

"During the total eclipse of 1882, both M. TREPIED and myself, fancied we observed on the edge of the lunar disk, a notable strengthening of the rays of the B group.

"If Captain ABNEY'S theory could have been confirmed, it would have certainly added great weight to our observations, and for my own part, I should have felt highly satisfied at the result. Unfortunately, the atmosphere of oxygen, which should now be attributed to the *Moon*, in order to produce the observed effects, seems scarcely reconcilable with the absence of refraction in the luminous rays striking the edge of our satellite. I greatly fear the results obtained in Egypt, are one of those illusions, of which nearly all spectroscopists have been more or less victims.

"It would now be important to ascertain whether the nitrogen and carbonic acid of the air may not be represented by any line or any group of the solar spectrum. The study I am at present engaged in, according to the above described method, will not fail, I trust, to yield precise results on this important point. Hitherto, apart from the oxygen groups, I have discovered no line that may be confidently attributed to the constant elements of the atmosphere. Hence, it is desirable to await the result of my researches, before giving effect to the project adopted by M. BISCHOFFSHEIM to establish Mont Gross metallic tubes of considerable length, in which the spectra of absorption gases may be studied on a grand scale.

Professor SIMON NEWCOMB'S paper in A. N. No. 2617, entitled, *Remarks on the theory of relations among the mean motions of the planets*, has several points of interest to those familiar with the principles of perturbations and the theories of related mean motions of

the planets. Professor BRUNS, of Leipsic, has recently called attention to such a relation between the mean motions of *Pallas* and *Jupiter*. From Professor HALL's discussion of his observations of *Hyperion*, Professor NEWCOMB has discovered a new relation between the motions of that satellite and *Titan*.

That relation is

$$4l'-3l-\pi'=180^\circ+H,\ H=-18^\circ \sin(\pi-\pi')$$

The accented quantities refer to the outer satellite *Titan*. The consequences are best stated in his own words:

"This remarkable relation results in the motion of the perisaturnium of *Hyperion* being totally different from what it should be by the ordinary theory of secular variations. This theory would give a direct motion not differing much from 3° or 4° per annum. The result of the above relation is that the theory of secular variations does not apply at all, since the two satellites never came into conjunction except near the aposaturnium of *Hyperion*.

Following this, Professor NEWCOMB discusses the mean motions of *Pallas* and *Jupiter*, in respect to the long period of 800 years computed by LEVERRIER. The method of work indicated for this difficult task seems ingeniously direct, but it is too abstruse for a popular summarizing at this time. He closes the paper by pointing out the fallacy frequently made by writers on the relations of mean motions, in supposing that if such a relation were almost exactly fulfilled, the stability of the system would be disturbed in consequence of the increase of perturbations without limit. While this might be so it does not necessarily follow from the circumstance supposed. He says: "The reason is, that as soon as the perturbations begin to develop themselves, the change in the longitude and other elements which they produce will speedily cause them to change their sign, and the only result will be a series of oscillations which may indeed be extremely irregular, but could only under exceptional circumstances destroy the stability."

The red skies are still attracting attention in all parts of the world. Full observations are reported in the foreign scientific papers, that seem to describe very well what is seen daily in America. At Northfield particular attention has been given to this phenomenon by naked eye observation for the last two months. Every clear day without exception the solar appendage appears which has often been described in these pages. It varies somewhat from day to day, to be sure, but this might be due to varying conditions of the atmosphere. The noteworthy feature, at the present time is the constancy of these sky-glows. One year ago they would appear, at times, with excessive brightness and remain in an after-glow for a surprisingly long time after sunset. Then several days might follow in which no marked

display would appear. The phenomenon then was a variable one decidedly. It is now essentially different in this particular. It is steady and strangely uniform in this latitude. If the cause of it be the great dust envelope of Krakatoa, as is still maintained by most astronomers and physicists, we ought to expect diminution and probably greater uniformity from day to day, especially if the volume of the eruption were sufficient to fill the whole upper atmosphere to so great a height as that indicated by the evening after-glows. Such a dust or gas mantle for the whole *Earth*, or a considerable zone of it, at such an altitude and continuing persistently for more than a year, seems indeed very incredible; yet it is the best explanation that science can now offer after a year of diligent study.

By kindness of a friend in California, we have the following account from an unknown local paper of the progress of work on the great telescope of the Lick Observatory:

The Lick Trustees have just received through the kindness of Captain GOODALL, of the firm of GOODALL, PERKINS & Co., important advices from Paris in regard to the glass disk which is needed to complete the thirty-six inch equatorial for the Lick Observatory. It will be remembered that the contract for two disks—one of flint and one of crown glass—which are needed for the construction of an achromatic objective, was let to the firm of ALVAN CLARK & SONS in 1881. There were only two firms in the world capable of making glass disks of such size. The CLARKS employed one of these, Messrs. E. FEIL & Co., of Paris, to cast the rough disks for them. The flint disk was cast in an unexpected short time, but the making of the crown disk has proved to be a matter of great difficulty, and this alone will have delayed the making of the large objective, and thus the completion of the Lick Observatory by several years. The Lick Trustees will have all the observatory, excepting the large telescope and the dome to contain it, finished and ready for work during 1885. As soon as two perfect disks of crown and flint glass are on hand the focal length of the telescope can be calculated and the size of the great dome be determined upon; and nothing can be done until this focal length is known. Nineteen trials have been made by the Messrs. FEIL to cast a perfect crown disk and a delay of more than two years has been incurred through the difficulties and risks of the operation. It appears through the letter of Captain GOODALL to Captain FLOYD, which has been referred to, that Messrs. FEIL have cast two disks which they expect to be suitable for the purpose. The Captain visited their works early in September, and they were expected to ship one of the disks to CLARK & SONS early in October. There is, then, reason to believe that the rough disks for the large telescope will soon be in the hands of the optician. The successful working of these disks into the proper curve for a perfect object-glass is a matter of great difficulty, but the skill which the CLARKS have acquired in making the objectives for the National Observatory (26 inches), the Observatory of the University of Virginia (26 inches), the Princeton College Observatory (23 inches), the Imperial Observatory of St. Petersburg (30 inches), leave no doubt that within two or three years after receipt of a perfect disk the whole 36 inch objective will be finished. While the objective is making, the dome and the mount-

ing can be constructed so that the whole delay is and has been due to the difficulties incident to the optician's work. The work on Mount Hamilton has progressed as far as possible under the present conditions, and it will not be long before California will possess the greatest observatory in the world, placed in the most favorable situation which can be found.

WOLF'S COMET.

The foreign observers speak of comet *c*, 1884, as a vague, nebulous mass, with central condensation, and without a tail. During the month of October it has been moving rapidly to the southeast. Elements of its orbit have been computed by CHANDLER, Dr. SCHUR and H. OPPENHEIM, all of which agree closely. Its brightness at Sept. 20 was taken as unity, and at the present writing (Oct. 24) it is 1.27. It is reported that it has already been seen by the naked eye in Alexandria, Egypt, which is probable. Nov. 1 this comet will be near the star *Theta* of *Pegasus*, a little to the south and west. It increases in right ascension daily about one-half degree and diminishes in declination about the same amount. With a small telescope or a good opera-glass, any person who knows its place ought to see it easily.

On the evening of October 24 this comet was seen near *Nu Pegasi*, that star being about eight minutes of arc east, and nearly on the same parallel of declination. The comet has a diameter of about three minutes of arc with ill-defined edges and a strong central condensation. It is not yet visible to the naked eye although its brightness is slowly increasing.

BRORSON'S COMET.

In the search for comets, new and old, Brorson's must not be forgotten. The time announced for its perihelion passage was Sept. 14. The time of previous returns, as given by computers, was as follows:

1846, February 25.
1857, March 27.
1868, April 17.
1873, October 10.
1879, March 30.

It will be remembered that this comet was captured by *Jupiter*, which made it, in fact, a citizen of the solar system. Its present orbit is due to a disturbance in 1842. As given by *L'Astronomie* (Vol. 3, No. 10) the date of near approach was May 27. By the disturbing effects of the planets its period has gradually diminished since 1846, the year of its discovery by Brorson, an amateur astronomer at Kiel.

OLBER'S COMET OF 1815.

Another interesting comet is expected soon to return, and it may already be within reach of the telescope, though not very probable. In *Astronomische Nachrichten* (Nos. 2613–14) von F. K. GINZEL has published a sweeping ephemeris extending from Oct. 1 to Jan. 1,

1885. Its perihelion passage for the present revolution should take place in December, 1886, but the discussions of observations during 1815 left an uncertainty in its period of 1.6 years, and on this account early preparations for a systematic search have been made. At the time of discovery by OLBERS it had the appearance of ENCKE'S comet and was just visible to the naked eye. It was observed for six months. Its orbit was computed by BESSEL.

BARNARD'S COMET.

The foreign papers have some interesting notes on BARNARD'S comet. M. GINIEIS, at Saint-Pons, on Sept. 11, made two observations of this comet. By a remarkable coincidence, the comet was just passing a star which gave it a brilliant central nucleus. Two hours later its motion showed it to be simply a diffused circular nebulous mass. According to the circulations of M. BERBERICH, this comet has an elliptic orbit, and a period of 2008 days, or 5½ years. The elements of its orbit are:

Perihelion passage 1884, Aug. 16, 48346, G. M. T.

Longitude of perihelion,	306° 7′ 31.″1	Mean Equinox 1884.
" " ascending node,	5 3 50. 2	
Inclination,	5 28 49. 6	
Angle of eccentricity,	36 3 43. 8	
Log. semi axis major,	0.493392	
Period of resolution,	5.4955 ^{y}	

This comet at aphelion, will be distant from *Jupiter* 0.503. When, at a true anomoly of 37° 13′, it will make a very close approach to the orbit of *Mars*, the distance being only 0.0088. One remarkable fact appears in the study of Dr. BERBERICH'S orbit; that between April 5 and 10, 1868, both *Mars* and this comet would pass very nearly the same point. In the first of this month its position is about 12° south of the star *Alpha* of *Aquarius*, among the small stars of that constellation and too distant to be seen by the telescope.

In a private letter under date Oct. 22, Mr. E. E. BARNARD says: "My comet has been observed regularly when the sky was sufficiently clear to see it. It has become very faint, and I suppose will not be visible after the present *Moon* disappears. I saw it last night (Oct. 21). It was exceedingly faint and difficult to observe, though two comparisons for position were obtained through clouds. October 20th it passed centrally over an 8th or 9th magnitude star. During the progress of transit, though the star shone through the comet's very center, I was surprised at the star's continuous flickering and occasionally almost total disappearance, at the same time an 8th magnitude star in the same field was steady."

"Over thirty positions of the comet have been obtained here."

By kindness of Director TATLOCK, Smith Observatory, Beloit, Wis., we have the following notes respecting the curious phenomenon (a

narrow white cloud stretching across the sky) referred to in last MESSENGER. He says: "I saw a similar appearance on the 17th of September, and by referring to my observing book I find the following:

1884, Sept. 17, $7^h\ 30^m$—Brilliant aurora. Arch about 12° in altitude. Dark cloud beneath.

$10^h\ 5^m$—The arch is lower, more brilliant, and at the western extremity streamers are flashing up toward the zenith to an altitude of about 40°.

$10^h\ 10^m$—The streamers have disappeared and the arch is fainter.

$11^h\ 20^m$—Streamers have reappeared in the north, and there is a belt of auroral light extending over the sky, meeting the Prime Vertical in the east and west points, and inclined to it about 5° to the south. The belt is about one degree wide.

$12^h\ 40^m$—The belt has disappeared and the arch is much fainter.

Mr. TATLOCK adds that he remembers seeing a similar appearance at Williamstown, Mass., in the spring of 1881. The belt then appeared in conjunction with a brilliant aurora in the north.

REMARKABLE RED STARS.

In comet sweeping I have noticed three remarkable red stars. They are all 7th magnitude nearly, and strikingly resemble each other. One is in,

R. A. $5^h\ 38^m\ 43^s.4$
Decl. $+30°\ 39'.1$ } 1884.4

Another in,

R. A. $18^h\ 58^m\ 12^s.2$
Decl. $-5°\ 59'$ } 1884.0

The third is somewhere in the drapery of *Saggittarius* although I have not found it again. With the 5-inch telescope and a power of thirty diameters (field $1\frac{1}{4}°$), these objects resemble a drop of blood, they are so intensely red. They are more remarkable in this particular than any I know of. If not there already they should be entered in the catalogues of red stars. E. E. BARNARD.

THE "ALMUCANTAR."

The new astronomical instrument known as the "Almucantar," not long ago invented by C. S. CHANDLER, Harvard College Observatory, is apparently fulfilling the predictions claimed for it. C. H. ROCKWELL, of Tarrytown Observatory, New York, has a 3-inch aperture instrument (if memory serves us rightly), and under date of October 7 he gives a copy of four consecutive days' work for clock correction as follows:

Beta Pegasi
Alpha Cor. Borealis } $+9^s.225$

Beta Herculis
Alpha Andromedæ } $+9.248$

} $+9.237$

Tau Pegasi Epsilon Cor. Borealis	+7.571	+7.590
Beta Herculis Alpha Andromedæ	+7.609	
Tau Pegasi Epsilon Cor. Borealis	+6.355	+6.381
Beta Herculis Alpha Andromedæ	+6.444	
Delta Herculis Delta Andromedæ	+6.343	
Epsilon Cor. Borealis Pi Andromedæ	+5.009	+4.963
Delta Herculis Delta Andromedæ	+4.917	

Professor C. L. DOOLITTLE, Lehigh University, South Bethlehem Pa., favors the MESSENGER with the following ring micrometer observations of comet Wolf:

1884	Beth. s. T.	Comet, App. α	Comet, App. δ
Sept. 25,	$21^h\ 34^m\ 46^s.4$	$21^h\ 18^m\ 6^s.39$	$20°\ 4'\ 38''.2$
" 26.	22 59 40 .3	21 18 47 .83	19 35 1 .8

1884	$\Delta\alpha$	$\Delta\delta$	Comp. Star.	No. of Comp.
Sept. 25	$-3^m1\ 5^s.03$	$-\ 8'\ 37''.6$	W. Bessell, XXI 473	7
" 26	+2 1 .21	+16 0 .4	American Ephemeris	7

ORBIT OF COMET WOLF (1884).

ELEMENTS.

T=1884, November 17.71070, Greenwich M. T.

$$\left.\begin{array}{rrrr} \pi-\Omega = & 172 & 36 & 40.5 \\ \Omega = & 206 & 27 & 36.5 \\ i = & 25 & 10 & 54.3 \end{array}\right\} 1884.0$$

log. q=0.196049
a=3.53638
e=0.556885
Period=2429 days=6.65 years.

The above were computed by Messrs. CHANDLER and WENDELL, from the following places, which have been corrected for parallax and aberration and referred to equinox 1884.0

A parabolic orbit had previously been computed from the same, observations as follows:—

T=1884, November 14.23309, Greenwich M. T.

$$\left.\begin{array}{rrrr} \pi-\Omega = & 170 & 40 & 36.0 \\ \Omega = & 197 & 16 & 24.3 \\ i = & 34 & 0 & 46.8 \end{array}\right\} 1884.0$$

log. q=0.273507.

but the residuals of the Middle Place: $(C-O)$

$$\Delta\lambda \cos.\beta = +7' \ 35''.8$$
$$\Delta\beta \quad\quad = -4' \ 40''.5$$

which could not be sensibly reduced, showed clearly the elliptical character of the orbit, and the above ellipse was accordingly computed.—*Science Observer Circular.*

The following orders and subscriptions have not been previously acknowledged: S. J. Corrigan, Nautical Office, Washington, D. C.; Professor C. L. Doolittle, Lehigh University, Bethlehem, Pa.; Professor Joseph Hall, Principal High School, Hartford, Conn.; Library State Normal School, Ypsilanti, Mich.; William Dawson, Spiceland, Indiana; Charles Schofield, Cannon Falls, Minn.

October 11 at 9 o'clock (Eastern Time) Mr. JOHN R. HOOPER, of Baltimore, reports that the Wolf comet was three times as bright as it was on the previous night. Mr. GILDERSLEVE, of the same place, observed the comet on the same night at 7 o'clock, and reports its appearance as on the previous night. It is possible that a great change in brightness took place between those two hours.

Three minor planets have been discovered recently. We omitted to notice No. (241) last month, which was discovered by Dr. LUTHER Sept. 12, $9^h\ 33^m$, in R. A., $0^h\ 45^m$; Decl. $+10°\ 35'\ 45''.9$. Magnitude 11.

Planet No. (242) whose name is *Germania*, was discovered by PALISA at Vienna, Sept. 22, 537.9. Its position in G. M. T. then was, R. A. $2^h\ 19^m\ 3^s.3$; Decl. $+14°\ 42'\ 33''$. Daily motion in R. A., -24^s; in Decl. $-5'$. Thirteenth magnitude.

Planet No. (243) was also discovered by PALISA, Sept. 29, $11^h\ 46^m.3$. Wien M. T. Right Ascension was, $2^h\ 18^m\ 26^s.3$; Decl. $+13°\ 47\ 7''$. Magnitude 13; daily motion in R. A. -32^s. in Decl. $-1'$.

The October number of *L'Astronomie* contains a notice of a proposed astronomical station in the south of Algeria. M. ALEXANDER BELLETETE points out the scientific advantages that would result from establishing an astronomical station in M'zab. The atmosphere is free from moisture and of great purity. The writer thinks that if the government would send an officer who was devoted to astronomy with a good telescope that would cost about as much as one of those mischievous cannon it would please peaceable people quite as well.

Mr. JOHN M. LEWIS, of Mount Vernon, Ohio, has a transit instrument for sale. Description as follows:

A superior portable astronomical transit, aperture three (3) inches; focus 33½; 5 vertical wires, two horizontal; total reflecting prism for high altitudes; sun-shade; lamp; setting circle; axis level; cast iron

stand with brass mountings; horizontal and vertical adjustments to axis; foot pieces, etc. The object glass is by ALVAN CLARK and is a very fine one, showing stars of the third magnitude by daylight. The instument is as good as new; bright and not marred. Price $325.00. Buff & Berger, of Boston, ask $480 for a similar instrument.

The eclipses of the *Moon* and *Sun* on October 4 and 18, respectively were of little interest to observers in America because invisible, and hence reports concerning them have been omitted.

On the 11th of November, *Saturn* is in conjunction with *Zeta Tauri*, a 3.5 magnitude star, the planet being 41 north of the star at time of conjunction.

Special attention is called to the new advertisements of Harvard Photometers, and telescope for sale.

Minima of *Algol. Beta Persei* occurs Nov. 9, 12^h 17^m in the evening, and Nov. 12, 9^h 6^m in the evening.

BOOK NOTICE.

COMPREHENSIVE PHYSIOLOGY. Messrs. J. B. Lippencott & Co., publishers, Philadelphia: 1884,

To one whose studies in anatomy began at a time when the works of Calvin Cutter were in extensive use, there comes a thrill of reminiscence at sight of the familiar name.

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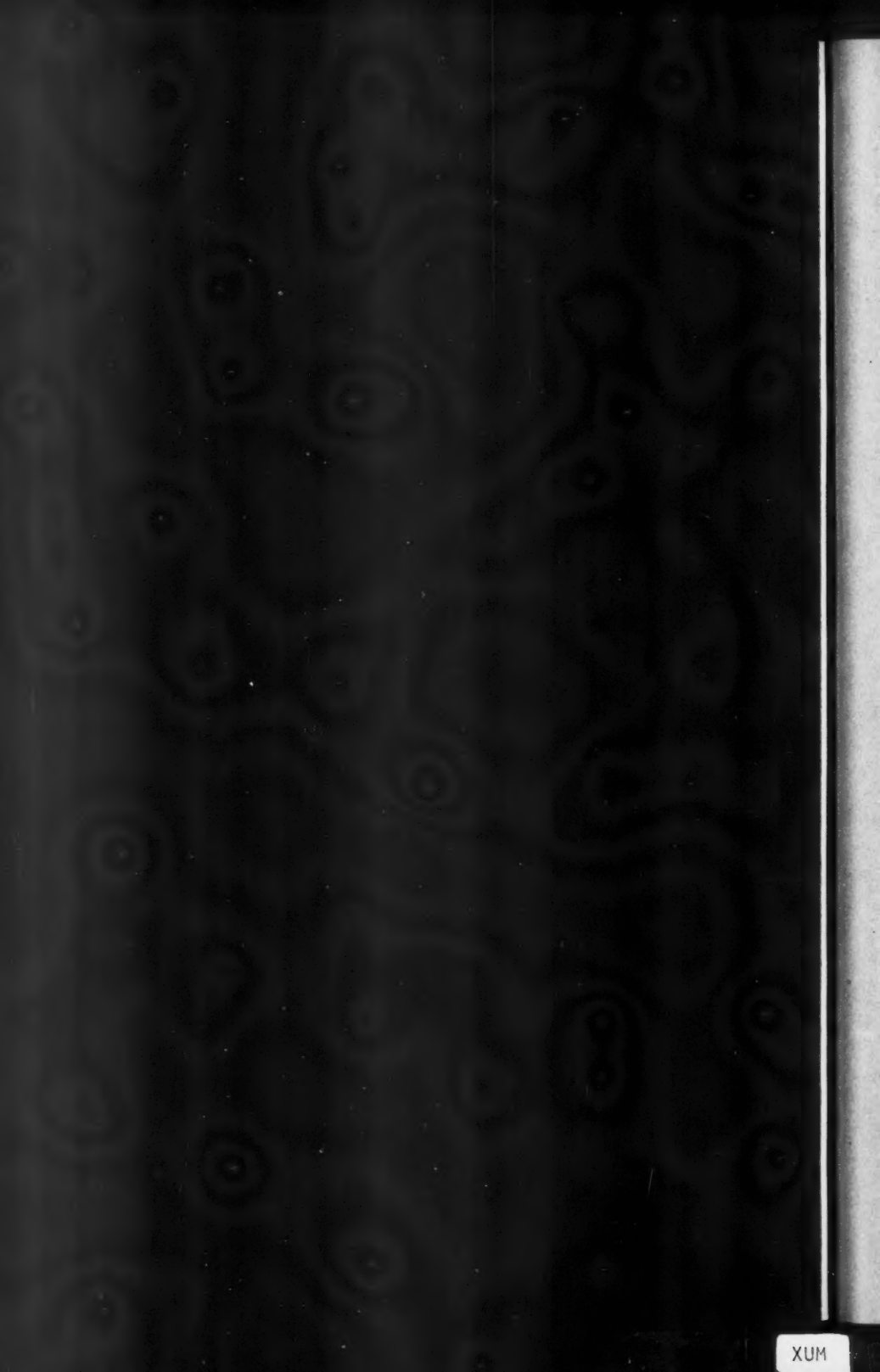
The growth of practical teaching in the natural sciences is one of the features of modern education. This book is the first effort to render possible experimental instruction in common schools on the important topic of anatomy. Starting with some valuable suggestions to teachers upon instruments, etc., at the beginning of each chapter, are admirably clear directions for dissection upon the lower animals These, when practicable, are performed by students, otherwise by the teacher in the presence of the class.

Another point worthy of attention is the combination of a brief with a more extended course. For teachers who have no access to larger works this will be a great boon. Many pupils will be able to do no more than the brief outline, but for the successful teaching of that a broader knowledge is needful. This book supplies it.

It may seem hypocritical to say in presence of so many excellent features that the plates are not in all cases up to the highest standard of such publications. Many of the old ones from the original Cutter's physiology seem to have been used. Some representing the anatomy of the skin are especially noticeable as being positively misleading. The work of the publishers in getting up the book is of course good.

L. W. C., JR.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CALENDAR.

Fall Term began Wednesday, September 10, 1884.
Term Examinations December 22 and 23, 1884.
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Term Examinations March 18 and 19, 1885.
Spring Term begins Wednesday, April 1, and ends June 18, 1885.
Examinations to enter College, June 12 and 13, and Sept. 8, 1885.
Term Examinations, June 16 and 17, 1885.
Anniversary Exercises, June 15–18, 1885.
Exhibition at the Art Room of work of Pupils in Drawing and Painting, June 15–18, 1885.
Wednesday, September 9, 1885, Fall Term begins.
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